# THE AERONAUTICAL JOURNAL

**Covering all aspects of Aerospace** 

Volume 115 Number 1163

January 2011





## THE AERONAUTICAL JOURNAL

**Editor-in-chief: Prof Peter Bearman** 

Associate Editors

Chairman: Prof Mike Graham

**Professor Chris Atkin** City University, London Professor Holger Babinsky University of Cambridge Professor Ken Badcock University of Liverpool Professor Rene de Borst Eindhoven University of Technology

Dr Trevor Birch

Wg Cdr Mike Bratby RAeS Air Power Group Professor Richard Brown University of Strathclyde, GlasgowP **Dr Jon Carrotte**Loughborough University

Professor Jonathan Cooper University of Liverpool

Mr Anthony Cross BAE Systems, Warton Professor Glyn Davies Imperial College, London **Dr Olivier Dessens** University of Cambridge

Professor Dimitris Drikakis
Cranfield University

Mr Chris Fielding BAE Systems, Warton

**Professor Nabil Gindy** University of Nottingham Professor Victor Giurgiutiu University of South Carolina

Professor Ismet Gursul University of Bath Professor Keith Hayward RAeS Head of Research Professor Michael J de C Henshaw Loughborough University Professor Richard Hillier Imperial College, London

Professor Howard Hodson University of Cambridge **Dr John Loizou** SELEX Systems Professor Ken Morgan Swansea University Dr Ravi Nayak National Aerospace Laboratories, India

Professor Gareth Padfield University of Liverpool Dr Shahrokh Shahpar Rolls-Royce Professor Marilyn Smith
Georgia Institute of Technology

Professor Constantinos Soutis University of Sheffield Professor John Stollery Cranfield University Professor Anthony Waas University of Michigan

#### Aims and scope

The aims and scope of *The Aeronautical Journal* are intended to reflect the objectives of the Royal Aeronautical Society as expressed in its Charter of Incorporation. Briefly, these are to encourage and foster the advancement of all aspects of aeronautical and space science. Thus the topics of *The Aeronautical Journal* include most of those covered by the various Specialist Groups of the Society, which include:

Aircraft design, aerodynamics, air law, air power, air transport, air navigation, airworthiness and maintenance, aviation medicine, avionics and systems, environmental issues, flight operations, flight simulation, fluid dynamics, fluid mechanics, general aviation, guided flight, human factors, human powered flight, light aviation, management studies, propulsion, rotorcraft, safety, space, structures and materials, structural mechanics, systems and test procedures and UAVs.

Papers are therefore solicited on all aspects of research, design and development, construction and operation of aircraft and space vehicles. Papers are also welcomed which review, comprehensively, the results of recent research developments in any of the above topics.

We recognise the inhibiting pressures of time and confidentiality and acknowledge that many of the design testing, manufacturing and operational problems that industry has to solve contain important information for the whole aerospace community. *The Aeronautical Journal* provides a platform for refereeing and presenting your work to an interest in a level to a platform of the whole aerospace community.

Papers will be considered for publication in *The Aeronautical Journal* if they meet the terms and conditions listed in The Instructions for authors. If these are not met, the Editor reserves the right to withdraw the paper without redress, which may be at any time up to publication.

Papers should be sent to: Prof Peter Bearman, Royal Aeronautical Society, No. 4 Hamilton Place, London W1J 7BQ, United Kingdom or publications@aerosociety.com

#### **Subscriptions**

#### Non-members

Annual subscription (12 issues) £399, Single copies, including back issues £36; Non-member subscription orders are available from; Royal Aeronautical Society, Publications Subscriptions Department, Dovetail Services Ltd, 800 Guillat Avenue, Kent Science Park, Sittingbourne, Kent ME9 8GU, UK.

Tel: +44 (0)844 848 8426, Fax: +44 (0)844 856 0650, email: ras@servicehelpline.co.uk

#### **RAeS** members

Annual subscription (12 issues) £69, Single copies, including back issues £6; member subscription orders are available from; Membership Department, Royal Aeronautical Society, No. 4 Hamilton Place, London W1J 7BQ, UK. Tel: +44 (0)20 7670 4300, Fax: +44 (0)20 7670 4309, email: membership@aerosociety.com

#### **RAeS Conference Proceedings**

Details, price and availability of Royal Aeronautical Society Conference Proceedings can be obtained from; RAeS Conference and Events Department, No. 4 Hamilton Place, London W1J 7BQ, UK. Tel: +44 (0)20 7670 4300, email: conference@aerosociety.com or via www.aerosociety.com/proceedings

All papers are available to view free of charge for subscribers and to purchase by others at: www.aerosociety.com



### **CONTENTS**

#### Volume 115 Number 1163

Reproduction of any of the papers published in this journal is not permitted without the written consent of the Editor.

#### Editor-in-Chief

Professor P W Bearman FREng FCGI FRAeS

#### **Managing Editor**

C S C Male BSc(Eng) MRAeS

#### **Production Editor**

W J Davis BA ARAeS

#### **Publications Officer**

A L Hallam BA ARAeS

#### Production

W I I Read MA(Econ) T C Robinson BA

#### **Book Review Editor**

B L Riddle BLib

#### Publisher

Royal Aeronautical Society (RAeS) No.4 Hamilton Place London W1J 7BQ, UK Tel: +44 (0)20 7670 4300 Fax: +44 (0)20 7670 4309

e-mail: publications@aerosociety.com raes@aerosociety.com

#### http://www.aerosociety.com

The Royal Aeronautical Society is a registered charity: No 313708

#### **RAeS Chief Executive**

S C Luxmoore MBA FRAeS

The content does not necessarily express the opinion of the Council of the Royal Aeronautical Society.

#### Advertisement Sales

Ben David Pelusa Media Sweetlands Barn Couchman Green Lane Staplehurst Kent, TN12 0RR, UK Tel: +44 (0)20 8406 0820 email: ben@pelusa.co.uk

#### Printer

Sunday Publishing Studio 2 First Floor Enterprise House 1 - 2 Hatfields London SE1 9P6, UK

ISSN: 0001-9240

#### **Published monthly**



A. Ania, D. Poirel and M.-J. Potvinolivier Kinematic and aerodynamic characterisation of the RotaFlap - a novel flapping wing mechanism R.M. Ajaj, G. Allegri and A.T. Isikveren Conceptual design and sizing of airframe panels according to safe-life acoustic fatigue criteria 15 C.-S. Lee, W.-L. Chan, S.-S. Jan and F.-B. Hsiao A linear-quadratic-Gaussian approach for automatic flight control 29 of fixed-wing unmanned air vehicles H. Moncayo, M.G. Perhinschi and J. Davis Aircraft failure detection and identification over an extended flight envelope using an artificial immune system 43 T. Gerlach Visualisation of the brownout phenomenon, integration and test on a helicopter flight simulator 57 **Book Reviews** 64

Front Cover. Northrop Grumman's RQ-4A/Global Hawk.